

US EPA ARCHIVE DOCUMENT

**MONITORING WELL INSTALLATION REPORT
STRECKER FOREST AND CALLAHAN PROPERTIES
ELLISVILLE SITE
St. Louis County, Missouri**

January 17, 2012

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INTRODUCTION

The U.S. Environmental Protection Agency (EPA) Region 7 Superfund Division initiated an Expanded Site Review (ESR) at property adjoining the Ellisville site located in Wildwood, Missouri, in early September of 2011. The study area for the ESR, as described in the “Expanded Site Review Work Plan for the Proposed Strecker Forest Development, Wildwood, Missouri” (Tetra Tech, 2011), includes the proposed Strecker Forest residential development and a portion of the Ellisville site known as the Callahan property. The Missouri Department of Natural Resources (MDNR), Division of Geology and Land Survey (DGLS), Geological Survey Program (GSP) assisted the EPA by conducting one component of the ESR, the installation of groundwater monitoring wells. This report describes the installation of three monitoring wells on the Strecker Forest property and three monitoring wells on the Callahan property designed to evaluate the direction of groundwater flow in the shallow bedrock aquifer and to determine if contaminants are present in groundwater.

SITE LOCATION

The Bliss subsite of the Ellisville site is located in Wildwood, Missouri, at 149 Strecker Road in west St. Louis County. The 18.3-acre proposed Strecker Forest development comprises three former residential tracts along the north side of Strecker Road; the Dozier property at 165 Strecker Road, the Primm property at 173 Strecker Road, and the Schoessel property at 177 Strecker Road. The Callahan property is located south of the Strecker Forest tract at 210 Strecker Road. These properties are located within the SE ¼ of the NE ¼ and the NE ¼ of the SE ¼ of Section 31, Township 45 North, Range 4 East of St. Louis County.

HISTORY

A summary of the site history and environmental actions at the site is provided in the work plan for the ESR (Tetra Tech, 2011). During previous site investigations monitoring wells were installed on the Bliss and Strecker Forest properties. Six wells were installed on the Bliss property (BMW-01 through BMW-06 on fig. 1). The first three were installed in 1997 as part of the remedial action on the Bliss property. The second three (BMW-04 through BMW-06 on fig. 1) were installed in 2010 by the Missouri Department of Natural Resources to further investigate groundwater (MDNR, 2010). In 2009, seven monitoring wells (MW-01 through MW-07 on fig. 1) were installed on the Strecker Forest property as part of a phase II environmental site assessment (Mundell, 2010). All of these monitoring wells were completed in the uppermost groundwater aquifer below the surface.

GENERAL GEOLOGIC AND HYDROLOGIC SETTING

The Strecker Forest and Callahan properties of the Ellisville site straddle a northwest trending ridge of the Caulks Creek drainage. Most surface-water runoff on the Strecker Forest property drains to the north to an unnamed tributary of Caulks Creek. Surface-

water runoff on the Callahan property drains generally south to another unnamed tributary of Caulks Creek. Caulks Creek flows north about 5 ½ miles to the Missouri River valley. Water tracing conducted by MDNR has shown that Caulks Creek and its tributaries are losing streams that recharge Lewis Spring located about 2 ½ miles north of the Ellisville site (MDNR, 1993).

Surficial materials on the hill slopes and ridge tops in the area are composed of cherty, clay-rich residual materials derived from the weathering of the carbonate bedrock. The valley floors of Caulks Creek and the Bliss property are filled with silty clay surface soils over chert gravel alluvial materials. The bedrock in the area is the Mississippian-age Burlington-Keokuk Limestone formation, a gray, cherty limestone that typically displays an irregular weathered surface with cutters and pinnacles. Shallow karst development is also typical of this bedrock formation. These surficial materials and bedrock are generally characterized as having moderate to high permeability.

WELL INSTALLATION

Three monitoring wells (MW-8, -9, and -10) were installed on the Strecker Forest property and three (MW-C01, -C02 and -C03) on the Callahan property by the GSP in September and October of 2011 (fig. 1). All six were drilled into bedrock and constructed to sample the uppermost groundwater aquifer, similar to the construction of existing monitoring wells. The wells were drilled with down-the-hole air hammer methods. The wells were drilled and constructed in accordance with the Missouri Well Construction Rules by GSP staff holding monitoring-well installer permits. All well construction materials used were purchased new and handled in a manner to keep them free of surface contaminants.

Drilling equipment was initially mobilized to the site on September 19, 2011 and drilling was initiated the next day. Drilling of the six wells was completed by October 4 with surface completions installed the following two days. The total depths of the wells ranged from 98 to 168 feet, however, only MW-C02, the first well drilled, was advanced deeper than 121 feet due to difficulty recognizing the uppermost point of saturation in that well. Groundwater recharges into MW-C02 more slowly than the other wells. Due to the initial uncertainty of the water level within the well, the well is constructed with a greater length of screen and sand pack than the other wells.

During the drilling and installation of well MW-C01, positioned at the base of 1983-drum excavation area, organic vapors were detected in the surficial soils near the top of bedrock. Due to the concern that contaminants were present during the drilling and installation of the well, a replacement well was drilled about 15 feet southeast of the original well. During the drilling of the replacement well, additional precautions were taken to isolate the surface soils by installing a temporary surface casing to the top of bedrock. Following the construction of the replacement well, the original MW-C01 well was plugged with bentonite grout through a tremmie pipe after removing the riser pipe. The well screen could not be recovered.

The wells were constructed with 2-inch, schedule 80 PVC flush-threaded riser pipe, factory slotted (0.010 inch slots) screen and above-ground completions. A 2-inch PVC well point was placed on the bottom of each well screen. The screen lengths for each well are 20 feet long, except for MW-C01 which is 30 feet and MW-C02 which is 60 feet. Well screens were positioned in an effort to bracket the groundwater surface within the screened interval, however, the water level in MW-10 rose above the screen several feet. Quartz sand was poured into the annular space from the surface to form a sand pack around the well screen to a depth at least 3 feet above the screen slots. Bentonite chips were similarly emplaced from the surface to form the bentonite seal and annular seal to within a few feet of the surface. Four-inch square steel protective casings were installed at each well and set in at least 2 feet of concrete to form a surface seal. Three bolsters, set in concrete, were placed around each well, except well MW-10 where only two bolsters were used since it was installed adjacent to a wooded area.

The well designations for wells installed on the Strecker Forest property (MW-08, -09 and -10) were chosen to follow the numbering of the initial seven installed by Mundell. The wells installed on the Callahan property included a 'C' in the well number. Measuring points on the rim of the riser pipes were also marked. Following the construction of the wells, water levels were measured in each well from the measuring point with an electronic water-level meter.

Following construction of the wells, the top-of-casing measuring-point elevations were surveyed using a self-leveling survey instrument and stadia rod. The measuring-point elevations of the casing tops of existing wells installed by Mundell were used as datums for the level survey. GSP staff developed the wells by surging and pumping them with a submersible pump and or bailer. Well construction details and location coordinates for the six wells are listed in table 1 below.

Table 1. Location coordinates and construction details for newly installed wells.

	MW-08	MW-09	MW-10	MW-C01	MW-C02	MW-C03
Latitude (dms)	38 35 55.2	38 35 56.4	38 36 00.4	38 35 47.4	38 35 50.5	38 35 50.3
Longitude (dms)	-90 36 17.2	-90 36 21.7	-90 36 18.9	-90 36 22.5	-90 36 22.4	-90 36 18.3
Borehole diameter (inches)	6.25	6.25	6.25	6.25	6.25	6.25
Total depth (ft)	112	119	120	98	168	121
Screen length (ft)	20.0	20.0	20.0	30.0	60.0	20.0
Measuring point elevation (ft msl)	713.71	720.91	705.09	695.21	728.12	722.47

Construction diagrams for the wells are attached to this report. Also attached are copies of daily field notes recorded during the project.

WATER LEVEL MEASUREMENT

In May of 2011 the Geological Survey Program began measuring water levels monthly in monitoring wells at the Ellisville site, including the six existing wells on the Bliss

property and the seven wells on the Strecker Forest property. Following construction and development of the six new monitoring wells on the Strecker Forest property, the static water levels within all existing monitoring wells were measured in order to determine the direction of groundwater flow at the Ellisville site. Table 2 lists water-level data compiled for all the existing monitoring wells at the Ellisville site. The compiled data includes water-level measurements reported by Mundell (2010) and measurements made during a well sampling event conducted by an EPA contractor on October 31, 2011 (Laura Price, personal communication, November 16, 2011). All measurements made by GSP staff used an electronic water-level indicator with 0.01-ft markings embossed on the measurement tape.

With few exceptions, the water-level measurements show consistency from one date to another. The water level in BMW-02 appears to fluctuate more than the other wells and may be more influenced by precipitation events than the water levels of other wells. Only one set of water-level measurements is available for all of the wells now present, the measurements made on December 2, 2011. The water level elevations from that data set have been plotted on a map of the site and contoured to provide a potentiometric surface map of the uppermost aquifer (fig. 2).

DISCUSSION

All of the wells constructed at the Ellisville site extend into the uppermost groundwater aquifer. Wells MW-02 and MW-C02, however, extend deeper into the aquifer than the other wells. The water levels of these two wells may be slightly deeper than if the wells were constructed similarly to the rest of the wells, however, the overall shape of the potentiometric surface and groundwater flow patterns would not likely be significantly different.

Based upon the data points available it appears that the shape of the uppermost groundwater surface beneath the site somewhat resembles the topographic surface. Groundwater beneath the northern portion of the Strecker Forest tract flows generally northeast toward the northwest arm of the Bliss property. From there, it appears that groundwater flows generally north. Groundwater beneath the western pond area of the Strecker Forest tract appears to flow south to southeast to meet northwest-flowing groundwater from the southeast corner of the Strecker Forest tract (former Dozier residence area). This groundwater then flows southwest toward the northwest corner of the Callahan property and subsequently flows generally to the west toward Caulks Creek.

As mentioned above, both Caulks Creek and its tributary that drains the Bliss property are losing streams and water tracing has demonstrated that these drainages recharge groundwater that discharges from Lewis Spring (MDNR, 1993).

REFERENCES

- Missouri Department of Natural Resources (MDNR). 1993. Report of Water Trace, Ellisville-Bliss Water Trace, St. Louis County, Missouri. Unpublished report of investigation. March 16, 1993.
- Missouri Department of Natural Resources (MDNR). 2010. Monitoring Well Installation Report, Bliss-Ellisville Site, Shallow Groundwater Investigation, St. Louis County. MDNR Division of Geology and Land Survey unpublished report. April 2010.
- Mundell & Associates, Inc. (Mundell). 2010. Phase II Environmental Site Assessment Report, Proposed Strecker Forest Development Site, 165, 173 and 177 Strecker Road, Wildwood, Missouri 63011. MUNDELL Project No. M08044. March 3, 2010.
- Tetra Tech EM Inc. (Tetra Tech). 2011. Expanded Site Review Work Plan for the Proposed Strecker Forest Development, Wildwood, Missouri. Superfund Technical Assessment and Response Team (START) Contract No. EP-S7-06-01, Task Order 0230, prepared for U.S. Environmental Protection Agency, Region 7. July 1, 2011.

Table 2. Ellisville site well location and water-level information.




Well ID	Latitude DMS	Longitude DMS	Latitude DDEG	Longitude DDEG	Installation Date	Total Depth (FT)	Ground Elevation	TOC Elevation	11/16/2009		5/4/2011	
									SWL ¹	ELEV	SWL	ELEV
BMW-01	38 35 59.465	90 36 12.687	38.599851	-90.603524	9/10/1997	52		651.63			35.83	615.80
BMW-02	38 36 2.666	90 36 8.135	38.600741	-90.60226	9/10/1997	50.3		649.93			33.80	616.13
BMW-03	38 36 6.199	90 36 14.654	38.601722	-90.604071	9/10/1997	54		638.15			30.48	607.67
BMW-04	38 36 7.410	90 36 14.738	38.602058	-90.604094	1/14/2010	65.2	637.75	642.41			35.94	606.47
BMW-05	38 36 7.537	90 36 15.859	38.602094	-90.604405	1/13/2010	54.4	632.45	637.21			32.66	604.55
BMW-06	38 36 6.385	90 36 16.673	38.601774	-90.604631	1/12/2010	62	630.53	635.15			29.37	605.78
MW-01	38 35 51.582	90 36 15.480	38.597662	-90.6043	10/28/2009	122	722.07	724.87	96.95	625.12	100.24	624.63
MW-02	38 35 51.903	90 36 21.184	38.597751	-90.605885	10/22/2009	151	724.26	727.02	110.20	614.06	113.36	613.66
MW-03	38 35 56.827	90 36 14.509	38.599119	-90.60403	11/3/2009	116	708.72	711.63	91.24	617.48	94.03	617.60
MW-04	38 35 59.071	90 36 16.240	38.599742	-90.604511	11/5/2009	73	662.53	665.48	46.78	615.75	48.78	616.70
MW-05	38 36 1.701	90 36 13.742	38.600473	-90.603817	11/5/2009	62	647.60	650.34	38.99	608.61	39.22	611.12
MW-06	38 36 4.178	90 36 14.274	38.601161	-90.603965	10/20/2009	47	637.51	640.14	28.64	608.87	31.65	608.49
MW-07	38 36 4.175	90 36 19.213	38.60116	-90.605337	11/6/2009	102	701.39	704.06	82.07	619.32	84.80	619.26
MW-08	38 35 55.2	90 36 17.2	38.59866	-90.60478	9/26/2011	112		713.71				
MW-09	38 35 56.4	90 36 21.7	38.599	-90.60602	9/27/2011	119		720.91				
MW-10	38 36 00.4	90 36 18.9	38.60011	-90.60525	9/28/2011	120		705.09				
MW-C01	38 35 47.4	90 36 22.5	38.5965	-90.60625	10/3/2011	98		695.21				
MW-C02	38 35 50.5	90 36 22.4	38.597361	-90.60622	9/20/2011	168		728.12				
MW-C03	38 35 50.3	90 36 18.3	38.597305	-90.605084	9/21/2011	121		722.47				
Notes:												
1. Water levels from Mundell (2010); reported as measured from ground surface on logs.												
2. Top-of-casing elevations for BMW wells based on the original three Bliss wells.												

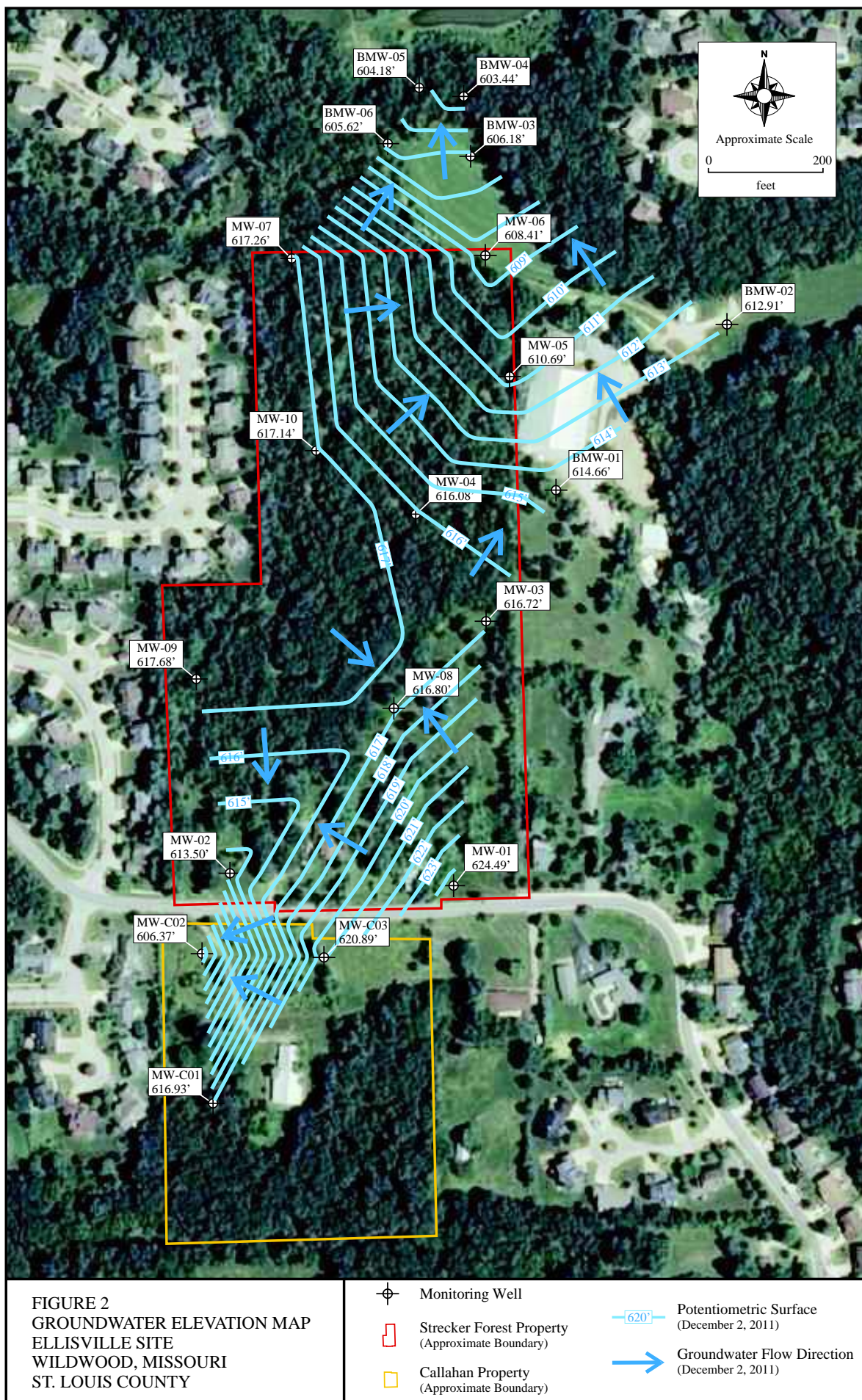
Table 2 (cont.). Ellisville site well location and water-level information.

Well ID	6/3/2011		7/6/2011		8/3/2011		9/2/2011		10/6/2011		10/31/2011		12/2/2011	
	SWL	ELEV	SWL	ELEV	SWL	ELEV	SWL	ELEV	SWL	ELEV	SWL	ELEV	SWL	ELEV
BMW-01	36.10	615.53	36.17	615.46	36.50	615.13	36.84	614.79					36.97	614.66
BMW-02	36.55	613.38	33.99	615.94	36.88	613.05	37.05	612.88					37.02	612.91
BMW-03	30.70	607.45	31.05	607.10	31.25	606.90	31.58	606.57					31.97	606.18
BMW-04	36.22	606.19	36.39	606.02	36.63	605.78	36.90	605.51					38.97	603.44
BMW-05	32.71	604.50	32.74	604.47	32.90	604.31	33.03	604.18					33.03	604.18
BMW-06	29.54	605.61	29.49	605.66	29.65	605.50	29.70	605.45					29.53	605.62
MW-01	99.78	625.09	99.65	625.22	99.37	625.50	99.70	625.17			99.96	624.91	100.38	624.49
MW-02	113.23	613.79	113.17	613.85	113.10	613.92	113.15	613.87			113.17	613.85	113.52	613.50
MW-03	93.90	617.73	94.04	617.59	94.11	617.52	94.41	617.22			94.67	616.96	94.91	616.72
MW-04	49.05	616.43	49.04	616.44	49.15	616.33	49.10	616.38			49.16	616.32	49.40	616.08
MW-05	39.31	611.03	39.40	610.94	39.56	610.78	39.56	610.78			39.66	610.68	39.65	610.69
MW-06	31.65	608.49	31.65	608.49	31.65	608.49	31.65	608.49			31.69	608.45	31.73	608.41
MW-07	85.01	619.05	85.20	618.86	85.42	618.64	86.35	617.71			86.65	617.41	86.80	617.26
MW-08									96.49	617.22	96.61	617.1	96.91	616.80
MW-09									102.88	618.03	102.92	617.99	103.23	617.68
MW-10									87.53	617.56	87.63	617.46	87.95	617.14
MW-C01									78.00	617.21	78.12	617.09	78.28	616.93
MW-C02									121.51	606.61	124.23	603.89	121.75	606.37
MW-C03									101.16	621.31	101.19	621.28	101.58	620.89



FIGURE 1
MONITORING WELL LOCATION MAP
ELLISVILLE SITE
WILDWOOD, MISSOURI
ST. LOUIS COUNTY

-  Monitoring Well
-  Strecker Forest Property
(Approximate Boundary)
-  Callahan Property
(Approximate Boundary)



FIELD NOTES – STRECKER FOREST / CALLAHAN PROPERTIES WELL INSTALLATION

09/20/11

Began drilling MW-C02 on the Callahan Property using air rotary with a 6 inch bit and a combined hammer and stabilizer length of 10 feet. The bit started bouncing and hammering at a depth of 4 feet, but was just on a residual piece of rock. At 13 to 14 feet began bouncing and hammering on cherty residuum. Drilled boring to a total depth of 168 feet (see well log).

Constructed well with 60 feet of 2 inch schedule 80 screen (with stainless steel centralizers at the bottom and top of the screen) and 110 feet of 2-inch schedule 80 riser (2 feet above the ground surface). The sand pack was constructed with 21.5 bags of sand (50 lb) to a depth of 103 feet below ground surface (5 feet above the top of the screen). Two bags of bentonite chips (50 lb bags) were placed above the sand pack and hydrated.

09/21/11

Checked the static water level in MW-C02 (from the top of the casing prior the installation of the above ground completion).

MW-C02

Time	Static Water Level (feet)
08:23	115.26
08:34	115.19
08:40	115.12
08:50	115.06

Began drilling MW-C03 on the Callahan Property using air rotary with a 6 inch bit and a combined hammer and stabilizer length of 10 feet. The bit started bouncing and hammering at a depth of 9 feet, but appeared to be just on a residual piece of rock. At 17 feet began bouncing and hammering on cherty residuum. Drilled boring to a total depth of 121 feet (see well log).

Constructed monitoring well MW-C03 with 20 feet of 2 inch schedule 80 screen (with stainless steel centralizers at the bottom and top of the screen) and 100 feet of 2-inch schedule 80 riser (1 foot above the ground surface). The screen and riser were suspended to a total depth of 119 feet (one foot of riser above the ground surface). The sand pack was constructed with 8.25 bags of sand (50 lb) to a depth of 94 feet below ground surface (5 feet above the top of the screen). A 3 foot bentonite seal was placed above the sand pack using medium bentonite chips (hydrated every foot or poured through standing water). The annular seal was placed above the bentonite seal using medium bentonite chips (hydrated every foot or poured through standing water). A total of 20.5 bags of medium bentonite chips were used for the bentonite seal and annular seal. A static water level of 119.07 feet was measured in monitoring well MW-C03 at 15:54.

09/22/11

A static water level of 107.00 feet was measured in monitoring well MW-C03 at 07:42.

Returned top monitoring well MW-C02 and emplaced the annular seal using medium bentonite chips (hydrated every foot or poured through standing water). A total of 21.5 bags of medium bentonite chips (50 lb bags) were used for the bentonite seal and annular seal.

Began drilling MW-C01 on the Callahan Property using air rotary with a 6 inch bit and a combined hammer and stabilizer length of 10 feet. The bit started bouncing and hammering at a depth of 12 feet and a strong toluene type odor was present. Had a hard time keeping hammer operating so added water at residuum/bedrock interface to clean out the hole after cleaning the hammer out. Had to add a little water to hole at a depth of 50 to 70 feet to keep the dust down. Drilled boring to a total depth of 100 feet. There were a few gallons of water that blew out of the hole after waiting about 20 minutes.

Constructed well with 20 feet of 2 inch schedule 80 screen (with stainless steel centralizers at the bottom and top of the screen) and 80 feet of 2-inch schedule 80 riser (2 foot above the ground surface). The screen and riser were suspended to a total depth of 98 feet (two foot of riser above the ground surface). The sand pack was constructed with 8 bags of sand (50 lb bags) to a depth of 73 feet below ground surface (5 feet above the top of the screen). A 3 foot bentonite seal was placed above the sand pack using medium bentonite chips (hydrated every foot or poured through standing water). The annular seal was placed above the bentonite seal using medium bentonite chips (hydrated every foot or poured through standing water). A total of 16 bags of medium bentonite chips were used for the bentonite seal and annular seal. A static water level of 73.85 feet was measured in monitoring well MW-C01 at 18:23. There was still an odor to the well at this time.

09/26/11

Brenna McDonald on-site to log wells.

Began drilling MW-08 on the Primm Property using air rotary with a 6 inch bit and a combined hammer and stabilizer length of 10 feet. Drilled boring to a total depth of 112 feet (see well log).

Constructed monitoring well MW-08 with 20 feet of 2 inch schedule 80 screen (with stainless steel centralizers at the bottom and top of the screen) and 100 feet of 2-inch schedule 80 riser (cut off 3.5 feet above the ground surface).

The sand pack was constructed with 7 bags of sand (50 lb bags) to a depth of 85.5 feet below ground surface (6.5 feet above the top of the screen). A 3 foot bentonite seal was

placed above the sand pack using medium bentonite chips (hydrated every foot or poured through standing water). The annular seal was placed above the bentonite seal using medium bentonite chips (hydrated every foot or poured through standing water). A total of 20 bags of medium bentonite chips were used for the bentonite seal and annular seal.

09/27/11

Brenna McDonald on-site to log wells.

Began drilling MW-09 on the Primm Property using air rotary with a 6 inch bit and a combined hammer and stabilizer length of 10 feet. Drilled boring to a total depth of 119 feet (see well log). Went to lunch and had water in the hole when they got back.

Constructed monitoring well MW-09 with 20 feet of 2 inch schedule 80 screen (with stainless steel centralizers at the bottom and top of the screen) and 100 feet of 2-inch schedule 80 riser (1 foot above the ground surface).

The sand pack was constructed with 6.5 bags of sand (50 lb bags) to a depth of 95 feet below ground surface (4 feet above the top of the screen). A 3 foot bentonite seal was placed above the sand pack using medium bentonite chips (hydrated every foot or poured through standing water). The annular seal was placed above the bentonite seal using medium bentonite chips (hydrated every foot or poured through standing water). A total of 23.5 bags of medium bentonite chips were used for the bentonite seal and annular seal.

09/28/11

Measured static water level in monitoring well MW-C01 at 77.19 feet below the top of casing (uncompleted well) at 08:03. Bailed 5 gallons of water from well with 3 foot stainless steel bailer. Re-measured static water level at 85.01 feet at 08:41 and 84.44 feet at 08:51. Put Grundfos pump in well with garden hose and tried to pump water. Pumped approximately $\frac{1}{4}$ gallon then it stopped pumping (pumped the hole dry filling the hose).

Began drilling MW-10 on the Primm Property using air rotary with a 6 inch bit and a combined hammer and stabilizer length of 10 feet. The bit started bouncing and hammering at a depth of 10 feet. Bit was getting hung up on a small ledge at approximately 25 feet (having a hard time lowering tools into hole with just the winch). Drilling dust went away at a depth of approximately 90 feet. Drilled boring to a total depth of 120 feet.

Constructed well with 20 feet of 2 inch schedule 80 screen (with stainless steel centralizers at the bottom and top of the screen) and 100 feet of 2-inch schedule 80 riser. The screen and riser went down to a total depth of 116 feet (4 feet of riser above ground)(4 feet of sluff in the hole). The sand pack was constructed with 7.5 bags of sand (50 lb bags) to a depth of 91 feet below ground surface (5 feet above the top of the screen). A 3 foot bentonite seal was placed above the sand pack using medium bentonite chips (hydrated every foot or poured through standing water). The annular seal was

placed above the bentonite seal using medium bentonite chips (hydrated every foot or poured through standing water). A total of 22.5 bags of medium bentonite chips were used for the bentonite seal and annular seal.

09/29/11

Returned to MW-C01 location to drill replacement well using a temporary surface casing. Started drilling at 12:00 using an 8 inch bit and a combined hammer and stabilizer length of 15 feet. Green soil on stabilizer at a depth of 7 to 10 feet with strong odor. It is not know just how thick the contaminated layer was since the soil was smeared on the hammer and stabilizer. Repeatedly cleaned off the hammer and stabilizer to allow for air flow. Added a few gallons of water to help clean out the hole. Put on dust deflector and added first drill stem. Started hammering at a depth of 13 feet. Turned off water valve to insure that no more water could enter the hole, but had to turn it back on due to gumming up of the hammer. Started hammering better at a depth of 23 feet. Up and down the hole to clean it out (ribs on stabilizer getting clogged up). Hammering steady at 27 feet. Drilled to 30 feet and cleaned out the hole. Some water in hole during cleanout. At 13:35 pulled out of the hole to set the temporary casing. Added 3 bags of medium bentonite chips to the hole and hydrated (brought the hole up to 24 feet total depth). Set 30 feet of 6 inch schedule 40 PVC in the hole (6 feet above the ground) and waited 15 minutes for the bentonite to hydrate some. Used drill rig to push the casing down 5 feet into the bentonite (1 foot above ground). Added 2.5 bags of bentonite into the annular space between boring and casing and hydrated. Pushed the casing down the remaining one foot to ground level. Switched to 6 inch hammer and stabilizer and attempted to start drilling. The hammer got stuck in the casing and blew out the seal. Pulled the casing up 4 feet and added 2 more bags of medium bentonite chips to the bottom of the hole. Waited 15 minutes and pushed the casing down again. Waited addition 20 minutes and attempted to drill again, but the seal blew out again. Decided to install temporary casing with cement and allow to set.

09/30/11

Pulled out the temporary casing and went back down the hole with the 8 inch hammer and stabilizer to clean out the hole. Pulled back out of the hole and added ½ bag of bentonite chips and then 4 sacks of portland cement (94 lb bags) mixed with 6 gallons of water per bag. Put the 6 inch SCH 40 PVC temporary casing back down the hole at 09:30 and added 6 bags of medium chips to annular space between boring and casing (hydrated).

10/03/11

Returned to MW-C01 location and measured 26 feet to the bottom of the hole inside the casing. Put 6 inch hammer and stabilizer in the hole and started drilling. Drilling dust went away at a depth of approximately 69 feet. Drilled the hole to a depth of 85 feet and waited 15 minutes and then blew about ½ gallon of water out of the hole. Decided to take the hole another 10 feet deep after comparing the total depth of the well at that time

to the water level in monitoring well MW-C02 (up the hill). Drilled the hole to a total depth of 98 feet.

Constructed monitoring well with 30 feet of 2 inch schedule 80 screen (with stainless steel centralizers at the bottom and top of the screen) and 70 feet of 2-inch schedule 80 riser (2 foot above the ground surface). The sand pack was constructed with 11 bags of sand (50 lb bags) to a depth of 63 feet below ground surface (5 feet above the top of the screen). A 3 foot bentonite seal was placed above the sand pack using medium bentonite chips (hydrated every foot or poured through standing water). The annular seal was placed above the bentonite seal using medium bentonite chips (hydrated every foot or poured through standing water) up to the bottom of the temporary casing. 6 bags of bentonite chips were used.

10/04/11

Measured static water level in the replacement monitoring well MW-C01 at 92.66 feet below the top of casing (uncompleted well) at 07:45 and slowly rising.

Pulled the temporary 6 inch PVC casing and added 6 more bags of medium bentonite chips (hydrated every foot or poured through standing water). A total of 18 bags of medium bentonite chips (including the 6 bags that were used in the annular space between the boring and temporary casing) were used for the bentonite seal and annular seal.

Finished the surface completions on monitoring wells MW-C01 (except for bolsters), MW-C02, MW-C03 and MW-08.

10/05/11

Attempted to pull the 2" screen and riser from the original MW-C01, but the riser broke off at the top joint (10 feet). Went to rolla to get extractor tool, tremmie pipe and powdered bentonite.

Returned to site and pulled a total of 80 feet of 2 inch riser from the original MW-C01. The screen broke off and would not pull due to the centralizers.

Put 1 inch PVC tremmie pipe down the hole to a depth of 70 feet (top of sand pack at 73 feet). Mixed 1 sack of bentonite powder with 25 gallons of water and pressure grouted the remaining hole with a Moyno pump.

10/06/11

Finished surface completions for MW-09 and MW-10.

Surveyed the top of casing of new wells to the top of casing of the nearest existing well and surveyed the 4 metal posts in the former pond area.

Station	Rod Location	Rod Reading (feet)	Elevation	
1	Primm TOC MW-02	4.22	*727.02	
1	Callahan TOC MW-C02 (GSP)	3.12	728.12	
2	Primm TOC MW-02	0.92	*727.02	
2	Callahan TOC MW-C03 (GSP)	5.47	722.47	
3	Callahan TOC MW-C02 (GSP)	1.58	728.12	
3	Leg 1	17.79	711.91	
4	Leg 1	0.89	711.91	
4	Callahan TOC MW-C01 (GSP)	17.59	695.21	
5	Top of Stake 1	7.26	714.78	
5	Top of Stake 2	6.70	715.34	
5	Top of Stake 3	6.37	715.67	
5	Top of Stake 4	6.37	715.67	
5	Primm TOC MW-09 (GSP)	1.13	720.91	
5	Leg 1	0.25	721.79	
6	Leg 1	5.76	721.79	
6	Primm TOC MW-02	0.53	*727.02	
7	Primm TOC MW-10 (GSP)	9.28	705.09	
7	Leg 1	13.58	700.79	
8	Leg 1	6.54	700.79	
8	Primm TOC MW-07	3.27	*704.06	
9	Primm TOC MW-03	8.29	*711.63	
9	Primm TOC MW-08 (GSP)	6.21	713.71	

*Previously reported top of casing elevation

Measured static water levels in new wells prior to attempting to develop the wells

Location	TOC elevation	SWL	GW Elevation	Time
Callahan MW-C01	695.21	78.00	617.21	14:17
Callahan MW-C02	728.12	121.51	606.61	09:48
Callahan MW-C03	722.47	101.16	621.31	13:52
Primm MW-08	713.71	96.49	617.22	14:26
Primm MW-09	720.91	102.88	618.03	14:33
Primm MW-10	705.09	87.53	617.56	11:41

Surged MW-C02 with a 3 foot stainless steel bailer and bailed 12 gallons of water from it.

Tried to surge MW-C03 but the 3 foot bailer became lodged in the bottom of the hole (fines in the well locked it up).

10/12/11

Arrived at Ellisville site 13:20 to develop monitoring wells.

Monitoring well MW-C02. Measured static water level at 124.19 feet below the top of casing at 13:30. Started pumping with Grundfos and ½ inch poly tubing. The pump controller shut off (over amps) several times. Pumped 5 gallons of water from the well by 15:22. Pumped another 5 gallons by 16:17 and another 2 gallons by 16:40. Measured the static water level at 141.72 feet below the top of the casing at 16:54 and 141.71 feet at 17:02.

Began bailing and bailed 5 gallons of water from the well by 09:43 and another 3 gallons of water by 09:55. Stopped bailing since lower bailer was only about ¼ full. Re-measured static water level at 109.76 feet below the top of casing at 09:58.

Moved to monitoring well MW-C03. Measured static water level at 100.67 feet below the top of casing at 17:09 and 112.80 feet from the top of casing down to the top of the stuck bailer.

10/13/11

Moved to monitoring well MW-C02. Measured static water level at 138.41 feet below the top of casing at 07:32.

Moved to monitoring well MW-08. Measured static water level at 96.12 feet below the top of casing at 07:46. Started pumping with Grundfos and ½ inch poly tubing at 08:00. Pumped 5 gallons of water from the well by 08:10. Pumped another 2 gallons by 08:12 and then ran out of water. Measured the static water level at 105.41 feet below the top of the casing at 08:37.

Moved to monitoring well MW-10. Measured static water level at 87.08 feet below the top of casing at 09:10. Started pumping with Grundfos and ½ inch poly tubing at 09:18. Pumped 5 gallons of water from the well by 09:26. Pumped another 5 gallons by 09:34, another 5 gallons by 09:44 and another 2 gallons by 09:50 and then ran out of water. Measured the static water level at 112.00 feet below the top of the casing.

Moved to monitoring well MW-09. Measured static water level at 102.40 feet below the top of casing. Started pumping with Grundfos and ½ inch poly tubing. Pumped a total of 10 gallons of water from the well then ran out of water. Measured the static water level at 115.45 feet below the top of the casing at 11:09 (after pumping).

Moved to monitoring well MW-C03. Measured static water level at 96.97 feet below the top of casing at 11:33. Dropped slug down the hole and surged up and down on a string. This loosened the stuck bailer for a moment (it went up and down a couple of feet), but then it locked up again. The slug started getting hung up on the bailer string, so was afraid to try again. Measured 113.5 feet to the top of the bailer from the top of casing.

Moved to monitoring well MW-C01. Measured static water level at 77.90 feet below the top of casing at 12:05. Started pumping with Grundfos and ½ inch poly tubing at 12:14. Pumped 5 gallons of water from the well by 12:24. Pumped another 5 gallons by 12:35 and then ran out of water. Measured the static water level at 93.51 feet below the top of the casing at 12:39.

Moved to monitoring well MW-C02. Measured static water level at 137.22 feet below the top of casing at 13:05.

Moved to monitoring well MW-08. Measured static water level at 97.38 feet below the top of casing at 13:12. Started pumping with Grundfos and ½ inch poly tubing at 13:45. Pumped 5 gallons of water from the well by 13:56. Pumped another ¼ gallon and then ran out of water. Measured the static water level at 104.65 feet below the top of the casing at 14:03.

Moved to monitoring well MW-10. Measured static water level at 87.18 feet below the top of casing at 14:19. Started pumping with Grundfos and ½ inch poly tubing at 14:37. Pumped 5 gallons of water from the well by 14:55. Pumped another 5 gallons by 15:16 and then another 5 gallons by 15:58. Measured the static water level at 103.15 feet below the top of the casing at 16:02.

Measured static water levels in wells

MW-09, static water level 103.09 feet at 16:29

MW-08, static water level 98.92 feet at 16:36

MW-C01, static water level 88.37 feet at 16:42

MW-C02, static water level 136.5 feet at 16:46

10/17/11

Arrived at Ellisville site 11:45

Got water from the Callahan residence (about 50 gallons) for cleaning purposes.

Monitoring well MW-C03 (3 foot stainless steel bailer stuck in the well). Measured the static water level at 101.08 feet below the top of casing. Measured 113 feet to the top of bailer from the top of casing. Put 110 feet of 1 inch tremmie pipe down the hole and pumped approximately 5 gallons of water to dislodge the bailer. The bailer wouldn't come free. Added another 10 feet of tremmie pipe and set it on top of the bailer and the bailer went down with little resistance (just the weight of the tremmie pipe). Applied

pressure to the bailer string slowly by winding it around a brush handle. The string stretched until it broke, but the bailer didn't move (recovered 68 feet of string). Measured 119.25 feet to top of bailer from the top of casing. Began developing well. Started pumping with the Grundfos with ½ inch poly tubing at 13:50. The pump controller kept shutting off (over amps), but pumped 5 gallons of water out of the well by 14:14 and another 5 gallons by 14:46.

Moved to monitoring well MW-C02. Measured the static water level at 126.21 feet below the top of casing at 15:12. Started pumping with Grundfos and ½ inch poly tubing at 16:10. The pump controller kept shutting off (over amps), so gave up on using Grundfos. Began using 2 disposable bailers (in-train on the same line) and bailed 5 gallons of water from the well by 16:48. Bailed another 5 gallon by 17:10, another 5 gallons by 17:30, another 5 gallons by 17:44 and another 3.5 gallons by 17:54. Measured the static water level at 165.80 feet below the top of the casing at 17:56.

10/18/11

Returned to monitoring well MW-C02. Measured static water level at 161.00 feet below the top of casing at 07:53. Bailed 4 gallons of water from well by 08:11. Re-measured static water level at 167.81 feet at 08:14

Moved to monitoring well MW-C03. Measured static water level at 101.43 feet below the top of casing at 08:47. Began bailing and bailed 5 gallons of water from the well by 09:02 and another 3 gallons of water by 09:13. Stopped bailing since lower bailer was only about ¼ full. Re-measured static water level at 115.79 feet below the top of casing at 09:16.

Moved to monitoring well MW-08. Measured static water level at 96.43 feet below the top of casing at 09:27. Began bailing and bailed 5 gallons of water from the well by 09:43 and another 3 gallons of water by 09:55. Stopped bailing since lower bailer was only about ¼ full. Re-measured static water level at 109.76 feet below the top of casing at 09:58.

Moved to monitoring well MW-09. Measured static water level at 102.71 feet below the top of casing at 10:09. Began bailing and bailed 5 gallons of water from the well by 10:25, another 5 gallons of water by 10:42 and another gallon of water by 10:47. Stopped bailing since lower bailer was only about ½ full.

Moved to monitoring well MW-10. Measured static water level at 87.37 feet below the top of casing at 11:02. Began bailing and bailed 5 gallons of water from the well by 11:17, another 5 gallons of water by 11:31, another 5 gallons of water by 11:51 and another 5 gallons of water by 12:11. Stopped bailing.

Moved to monitoring well MW-C01. Measured static water level at 77.97 feet below the top of casing at 12:58. Began bailing and bailed 5 gallons of water from the well by

13:12, another 5 gallons of water by 13:23 and another 4 gallons of water by 13:35. Re-measured static water level at 98.97 feet below the top of casing at 13:37.

Moved to monitoring well MW-C02. Measured static water level at 166.08 feet below the top of casing at 13:51. Began bailing and bailed 2 gallons of water from the well by 14:05.

Moved to monitoring well MW-C01. Measured static water level at 98.08 feet below the top of casing at 14:14.

Moved to monitoring well MW-C03. Measured static water level at 108.85 feet below the top of casing at 14:20. Began bailing and bailed 5 gallons of water from the well by 14:43 and another gallon of water by 14:48. GPS location coordinates: N 38° 35' 50.3", W 090° 36' 18.3"

Moved to monitoring well MW-08. Measured static water level at 98.36 feet below the top of casing at 15:00. Began bailing and bailed 5 gallons of water from the well by 15:16. Collected GPS location data N 38° 35' 55.2", W 090° 36' 17.2"

Moved to monitoring well MW-09. Measured static water level at 104.86 feet below the top of casing at 15:28. Collected GPS location data N 38° 35' 56.4", W 090° 36' 21.7"

Moved to monitoring well MW-10. Measured static water level at 87.57 feet below the top of casing at 15:37. Began bailing and bailed 4 gallons of water from the well by 15:50. Collected GPS location data N 38° 36' 00.4", W 090° 36' 18.9"

Moved to monitoring well MW-C02. Collected GPS location data N 38° 35' 50.5", W 090° 36' 22.4"

Moved to monitoring well MW-C01. Collected GPS location data N 38° 35' 47.4", W 090° 36' 22.5"

Ellisville Site – Wildwood, Missouri
Addendum to Field Notes, October 6, 2011

The field notes produced by Glen Young on October 6, 2011 contained top of casing survey data for the new monitoring wells (MW-C01, MW-C02, MW-C03, MW-08, MW-09 and MW-10) installed at the site. The survey tied the top of casing elevations of existing wells at the site to the top of casing elevations of the new wells and to the top of four stakes in the former pond area at the site. Unfortunately, the elevation data that was utilized as the top of casing elevation for the existing wells was actually the ground elevation for those wells taken from the well boring logs. This resulted in erroneous top of casing elevations for the wells reported in the field notes.

The following table contains the revised top of casing elevations for the new monitoring wells and the top of the four stakes at the site.

Location	Elevation
MW-C01 (Top of Casing)	695.21
MW-C02 (Top of Casing)	728.12
MW-C03 (Top of Casing)	722.47
MW-08 (Top of Casing)	713.71
MW-09 (Top of Casing)	720.91
MW-10 (Top of Casing)	705.09
Stake 1 (Top of Stake)	714.78
Stake 2 (Top of Stake)	715.34
Stake 3 (Top of Stake)	715.67
Stake 4 (Top of Stake)	715.67

The following page replaces the page found in the Field Notes from October 6, 2011.

Surveyed the top of casing of new wells to the top of casing of the nearest existing well and surveyed the 4 metal posts in the former pond area.

Station	Rod Location	Rod Reading (feet)	Elevation	
1	Primm TOC MW-02	4.22	*727.02	
1	Callahan TOC MW-02 (GSP)	3.12	728.12	
2	Primm TOC MW-02	0.92	*727.02	
2	Callahan TOC MW-03 (GSP)	5.47	722.47	
3	Callahan TOC MW-02 (GSP)	1.58	728.12	
3	Leg 1	17.79	711.91	
4	Leg 1	0.89	711.91	
4	Callahan TOC MW-01 (GSP)	17.59	695.21	
5	Top of Stake 1	7.26	714.78	
5	Top of Stake 2	6.70	715.34	
5	Top of Stake 3	6.37	715.67	
5	Top of Stake 4	6.37	715.67	
5	Primm TOC MW-09 (GSP)	1.13	720.91	
5	Leg 1	0.25	721.79	
6	Leg 1	5.76	721.79	
6	Primm TOC MW-02	0.53	*727.02	
7	Primm TOC MW-10 (GSP)	9.28	705.09	
7	Leg 1	13.58	700.79	
8	Leg 1	6.54	700.79	
8	Primm TOC MW-07	3.27	*704.06	
9	Primm TOC MW-03	8.29	*711.63	
9	Primm TOC MW-08 (GSP)	6.21	713.71	

*Previously reported top of casing elevation

Measured static water levels in new wells prior to attempting to develop the wells

Location	TOC elevation	SWL	GW Elevation	Time
Callahan MW-01	695.21	78.00	617.21	14:17
Callahan MW-02	728.12	121.51	606.61	09:48
Callahan MW-03	722.47	101.16	621.31	13:52
Primm MW-08	713.71	96.49	617.22	14:26
Primm MW-09	720.91	102.88	618.03	14:33
Primm MW-10	705.09	87.53	617.56	11:41



MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: **MW-08**

TOTAL DEPTH: **112**

PROJECT INFORMATION

PROJECT: **Bliss-Ellisville**
SITE LOCATION: **Primm Property**
CITY/COUNTY: **St. Louis County**
LOGGED BY: **Brenna McDonald**
PROJECT MANAGER: **Don Van Dyke**
DATES DRILLED: **09-26-2011**

DRILLING INFORMATION

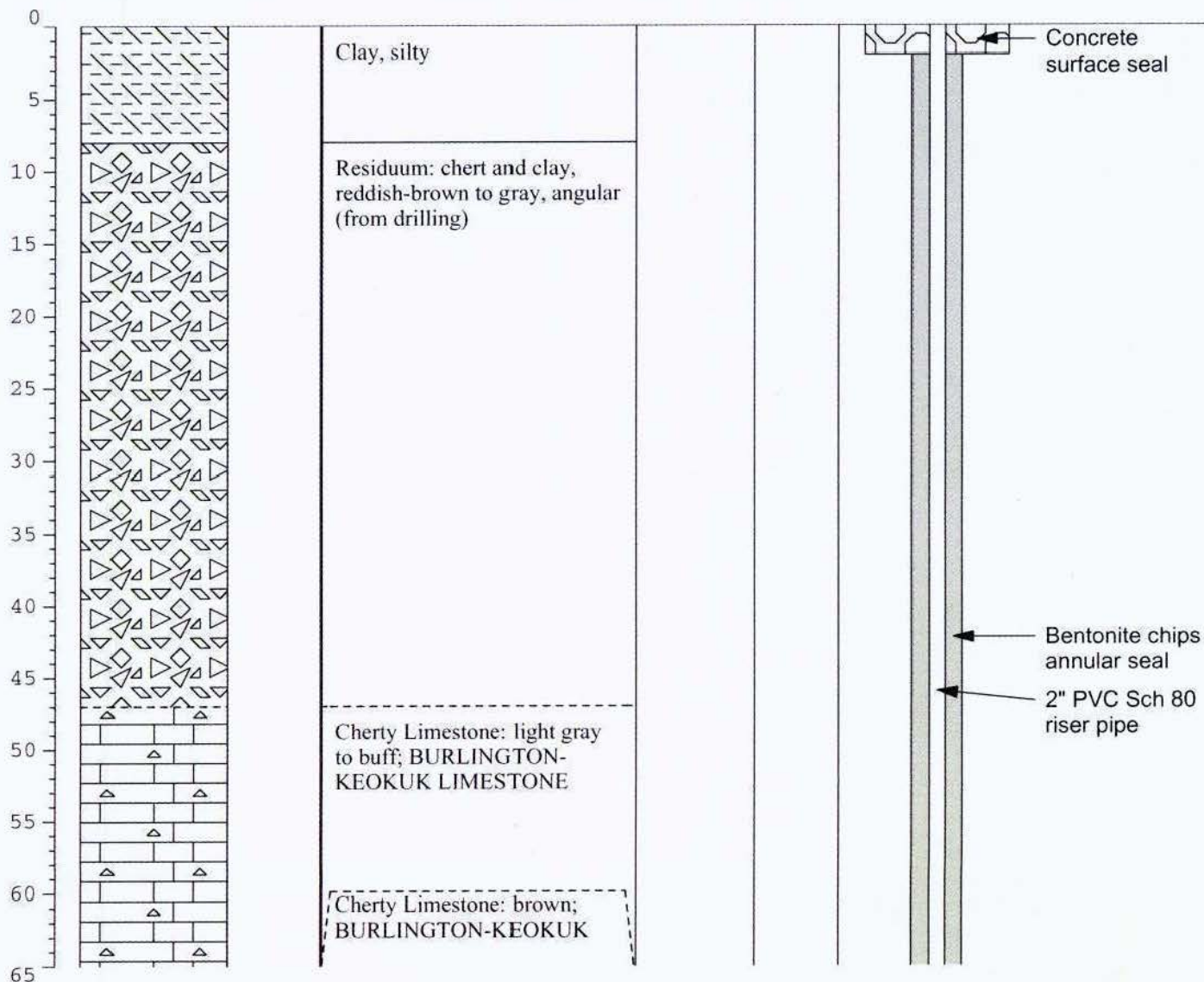
DRILLER: **Dan Nordwald**
RIG TYPE: **Simco 7000**
METHOD OF DRILLING: **6" air hammer**
LATITUDE/LONGITUDE: **N 38 35 55.2 W 90 36 17.2**
SURFACE ELEVATION:
MEASURING PT ELEV: **713.71**

☒ Water level during drilling

☒ Water level in completed well 96.49

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
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NOTES: Above ground completion. Measuring point at top of riser pipe.

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MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: MW-08

TOTAL DEPTH: 112

PROJECT INFORMATION

DRILLING INFORMATION

PROJECT: Bliss-Ellisville
SITE LOCATION: Primm Property
CITY/COUNTY: St. Louis County
LOGGED BY: Brenna McDonald
PROJECT MANAGER: Don Van Dyke
DATES DRILLED: 09-26-2011

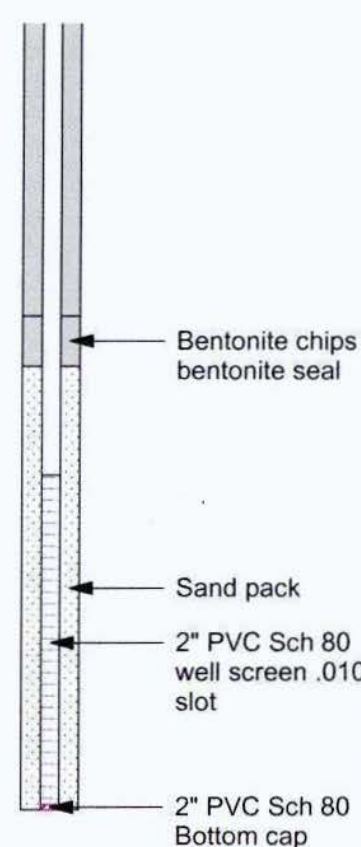
DRILLER: Dan Nordwald
RIG TYPE: Simco 7000
METHOD OF DRILLING: 6" air hammer
LATITUDE/LONGITUDE: N 38 35 55.2 W 90 36 17.2
SURFACE ELEVATION:
MEASURING PT ELEV: 713.71

☞ Water level during drilling

☛ Water level in completed well 96.49

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
65			LIMESTONE				
70			Cherty Limestone: gray to buff; BURLINGTON-KEOKUK LIMESTONE				
75							
80							
85							
90							
95							
100			Cherty Limestone: gray to bluish-gray; BURLINGTON-KEOKUK LIMESTONE				
105			Cherty Limestone: light gray; BURLINGTON-KEOKUK LIMESTONE				
110							
115							
120							
125							



Bentonite chips bentonite seal

Sand pack

2" PVC Sch 80 well screen .010 slot

2" PVC Sch 80 Bottom cap

NOTES: Above ground completion. Measuring point at top of riser pipe.

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MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: MW-09

TOTAL DEPTH: 119

PROJECT INFORMATION

DRILLING INFORMATION

PROJECT: Bliss-Ellisville
SITE LOCATION: Primm Property
CITY/COUNTY: St. Louis County
LOGGED BY: Brenna McDonald
PROJECT MANAGER: Don Van Dyke
DATES DRILLED: 09-27-2011

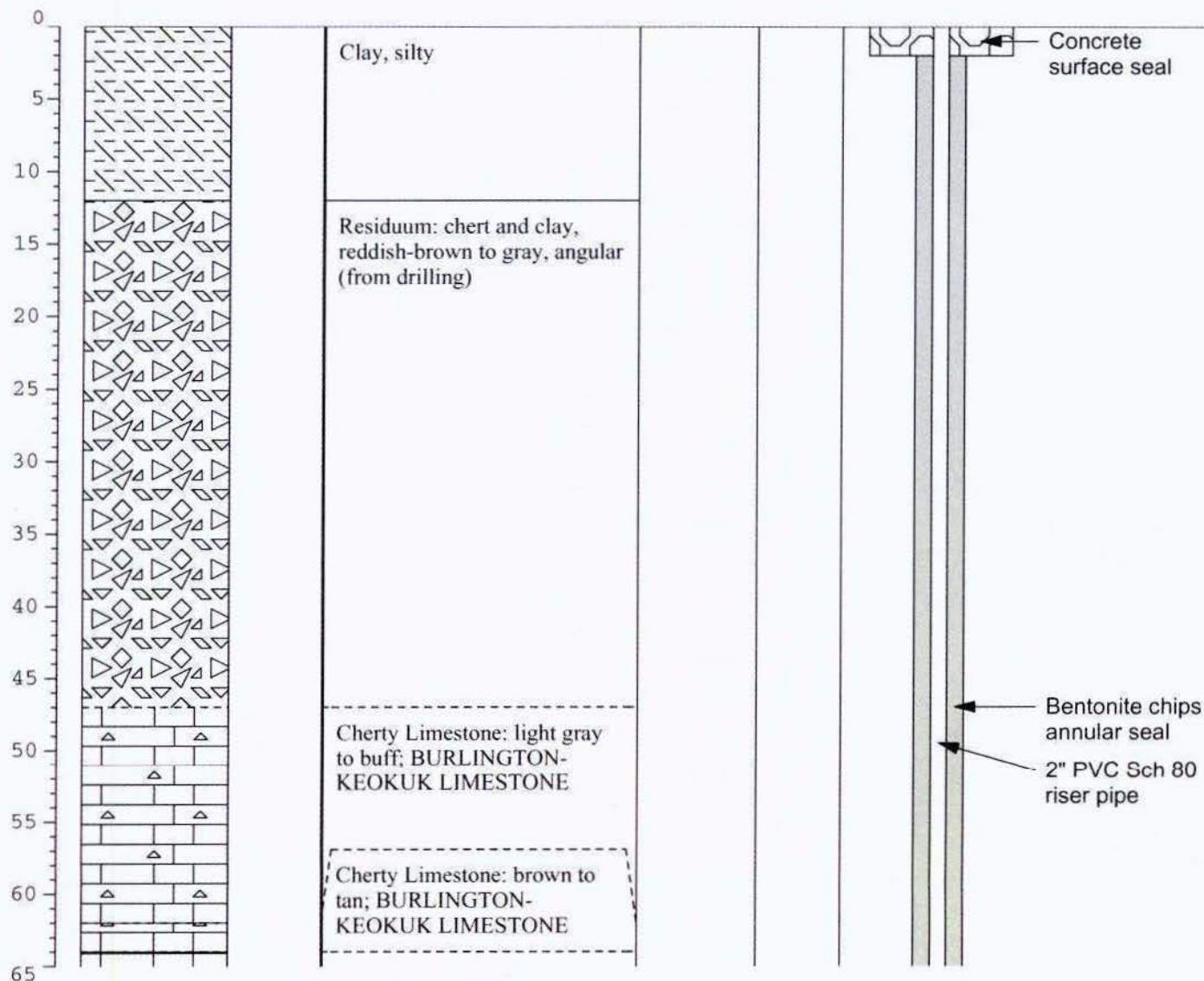
DRILLER: Dan Nordwald
RIG TYPE: Simco 7000
METHOD OF DRILLING: 6" air hammer
LATITUDE/LONGITUDE: N 38 35 56.4 W 90 36 21.7
SURFACE ELEVATION:
MEASURING PT ELEV: 720.91

☞ Water level during drilling

☒ Water level in completed well 102.88

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
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NOTES: Above ground completion. Measuring point at top of riser pipe.



MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: **MW-09**
TOTAL DEPTH: **119**

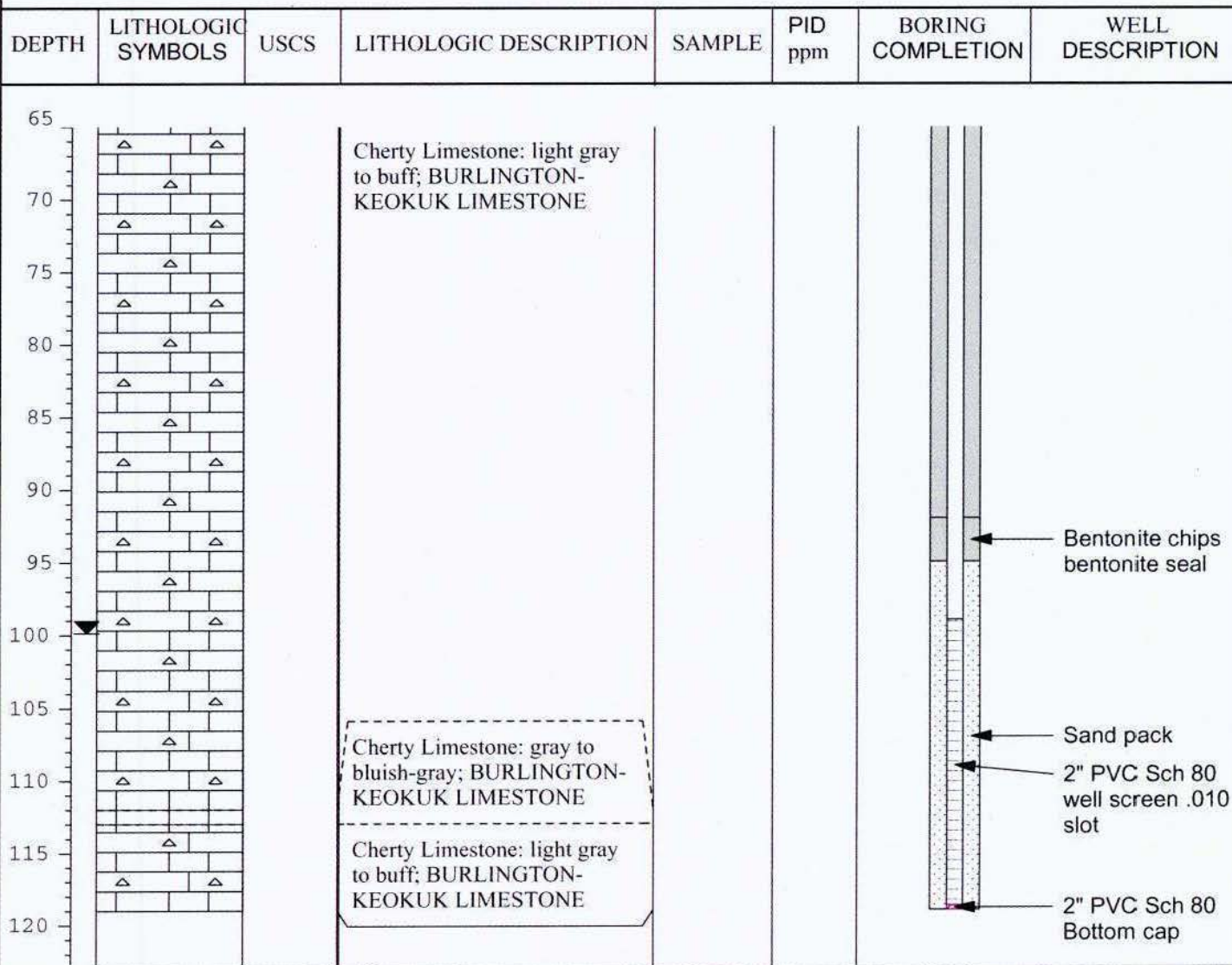
PROJECT INFORMATION

PROJECT: **Bliss-Ellisville**
SITE LOCATION: **Primm Property**
CITY/COUNTY: **St. Louis County**
LOGGED BY: **Brenna McDonald**
PROJECT MANAGER: **Don Van Dyke**
DATES DRILLED: **09-27-2011**

DRILLING INFORMATION

DRILLER: **Dan Nordwald**
RIG TYPE: **Simco 7000**
METHOD OF DRILLING: **6" air hammer**
LATITUDE/LONGITUDE: **N 38 35 56.4 W 90 36 21.7**
SURFACE ELEVATION:
MEASURING PT ELEV: **720.91**

☞ Water level during drilling ☛ Water level in completed well 102.88 Oct. 6, 2011



NOTES: Above ground completion. Measuring point at top of riser pipe.



MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: **MW-10**
TOTAL DEPTH: **120**

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	Bliss-Ellisville	DRILLER:	Dan Nordwald/Glen Young
SITE LOCATION:	Primm Property	RIG TYPE:	Simco 7000
CITY/COUNTY:	St. Louis County	METHOD OF DRILLING:	6" air hammer
LOGGED BY:	Glen Young	LATITUDE/LONGITUDE:	N 38 36 00.4 W 90 36 18.9
PROJECT MANAGER:	Don Van Dyke	SURFACE ELEVATION:	
DATES DRILLED:	09-28-2011	MEASURING PT ELEV:	705.09

☒ Water level during drilling

☒ Water level in completed well

87.53

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
0			Residuum: chert and clay, reddish-brown to gray, angular (from drilling)				Concrete surface seal
5							
10							
15							
20							
25							
30							
35							
40							
45							
50			Cherty Limestone: light gray; BURLINGTON-KEOKUK LIMESTONE				
55							
60							
65							
			Cherty Limestone: brown; BURLINGTON-KEOKUK LIMESTONE				
			Cherty Limestone: light gray to buff; BURLINGTON-KEOKUK LIMESTONE				

NOTES: Above ground completion. Measuring point at top of riser pipe.

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Department of Natural Resources
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Well Construction Log

WELL NO.: **MW-10**

TOTAL DEPTH: **120**

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	Bliss-Ellisville	DRILLER:	Dan Nordwald/Glen Young
SITE LOCATION:	Primm Property	RIG TYPE:	Simco 7000
CITY/COUNTY:	St. Louis County	METHOD OF DRILLING:	6" air hammer
LOGGED BY:	Glen Young	LATITUDE/LONGITUDE:	N 38 36 00.4 W 90 36 18.9
PROJECT MANAGER:	Don Van Dyke	SURFACE ELEVATION:	
DATES DRILLED:	09-28-2011	MEASURING PT ELEV:	705.09

☞ Water level during drilling

☛ Water level in completed well 87.53

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
65							
70							
75							
80							
85							
90							
95							
100							
105							
110							
115							
120							

Cherty Limestone: light gray;
BURLINGTON-KEOKUK
LIMESTONE

Cherty Limestone: light gray
to buff; BURLINGTON-
KEOKUK LIMESTONE

Cherty Limestone: gray to
bluish-gray and buff
(alternating); BURLINGTON-
KEOKUK LIMESTONE

Cherty Limestone: bluish-
gray; BURLINGTON-
KEOKUK LIMESTONE

Bentonite chips
bentonite seal

Sand pack

2" PVC Sch 80
well screen .010
slot

2" PVC Sch 80
Bottom cap

Borehole
collapse

NOTES: Above ground completion. Measuring point at top of riser pipe.

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MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: MW-C01
TOTAL DEPTH: 98

PROJECT INFORMATION

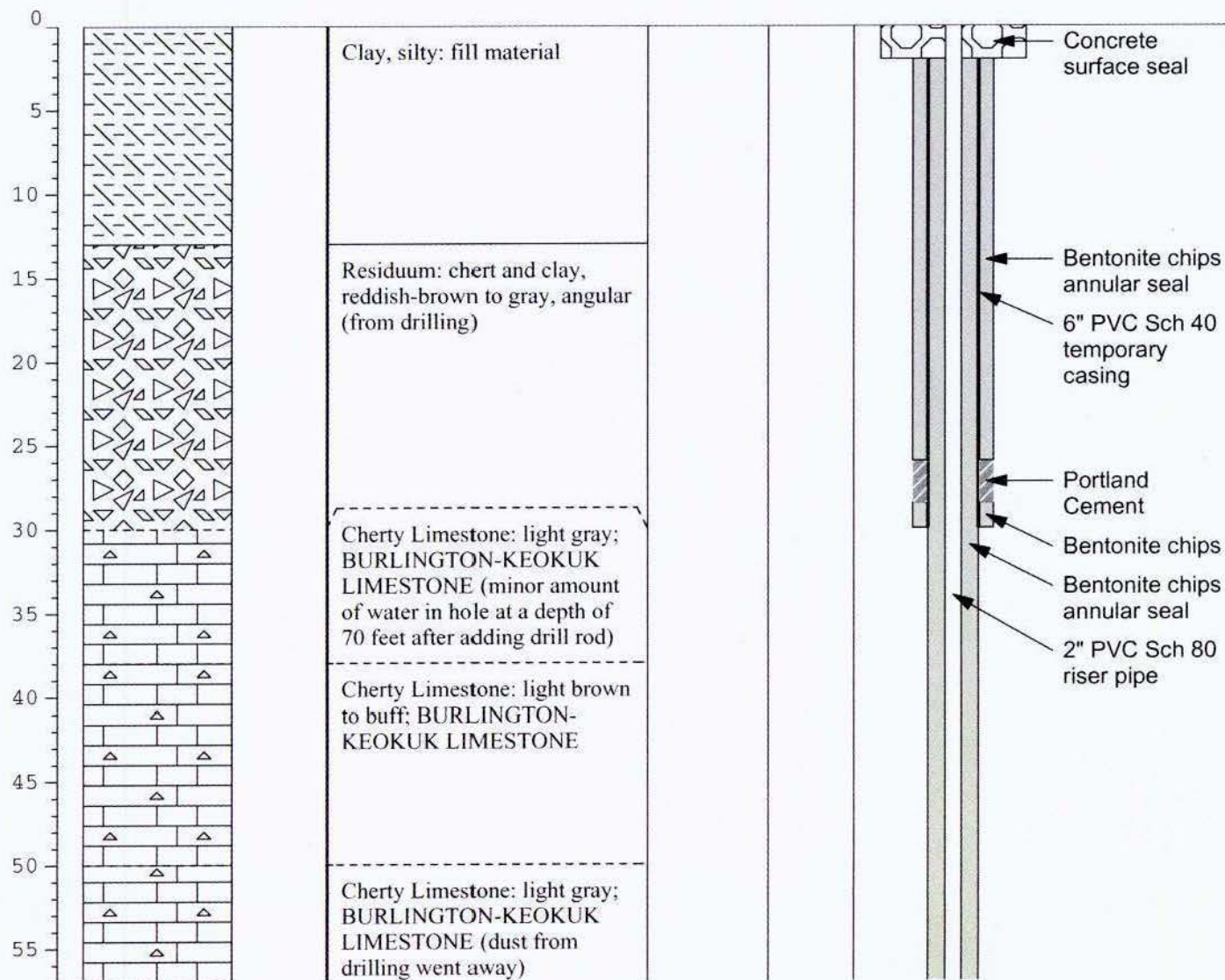
PROJECT: Bliss-Ellisville
SITE LOCATION: Callahan Property
CITY/COUNTY: St. Louis County
LOGGED BY: Glen Young
PROJECT MANAGER: Don Van Dyke
DATES DRILLED: 09-29-2011 to 10-03-2011

DRILLING INFORMATION

DRILLER: Dan Nordwald/Glen Young
RIG TYPE: Simco 7000
METHOD OF DRILLING: 8" and 6" air hammer
LATITUDE/LONGITUDE: N 38 35 47.4 W 90 36 22.5
SURFACE ELEVATION:
MEASURING PT ELEV: 695.21

☞ Water level during drilling ☞ Water level in completed well 78.00 Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
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NOTES: Above ground completion. Measuring point at top of riser pipe.



MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: MW-C01

TOTAL DEPTH: 98

PROJECT INFORMATION

DRILLING INFORMATION

PROJECT: Bliss-Ellisville
SITE LOCATION: Callahan Property
CITY/COUNTY: St. Louis County
LOGGED BY: Glen Young
PROJECT MANAGER: Don Van Dyke
DATES DRILLED: 09-29-2011 to 10-03-2011

DRILLER: Dan Nordwald/Glen Young
RIG TYPE: Simco 7000
METHOD OF DRILLING: 8" and 6" air hammer
LATITUDE/LONGITUDE: N 38 35 47.4 W 90 36 22.5
SURFACE ELEVATION:
MEASURING PT ELEV: 695.21

☞ Water level during drilling

☞ Water level in completed well 78.00

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
60							
65							
70							
75			Cherty Limestone: light brown to buff; BURLINGTON-KEOKUK LIMESTONE				
80							
85			Cherty Limestone: gray to bluish-gray; BURLINGTON-KEOKUK LIMESTONE				
90							
95							
100							

Bentonite chips bentonite seal

Sand pack

2" PVC Sch 80 well screen .010 slot

2" PVC Sch 80 bottom cap

NOTES: Above ground completion. Measuring point at top of riser pipe.

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MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: **MW-C02**
TOTAL DEPTH: **168**

PROJECT INFORMATION

DRILLING INFORMATION

PROJECT: **Bliss-Ellisville**
SITE LOCATION: **Callahan Property**
CITY/COUNTY: **St. Louis County**
LOGGED BY: **Glen Young**
PROJECT MANAGER: **Don Van Dyke**
DATES DRILLED: **09-20-2011**

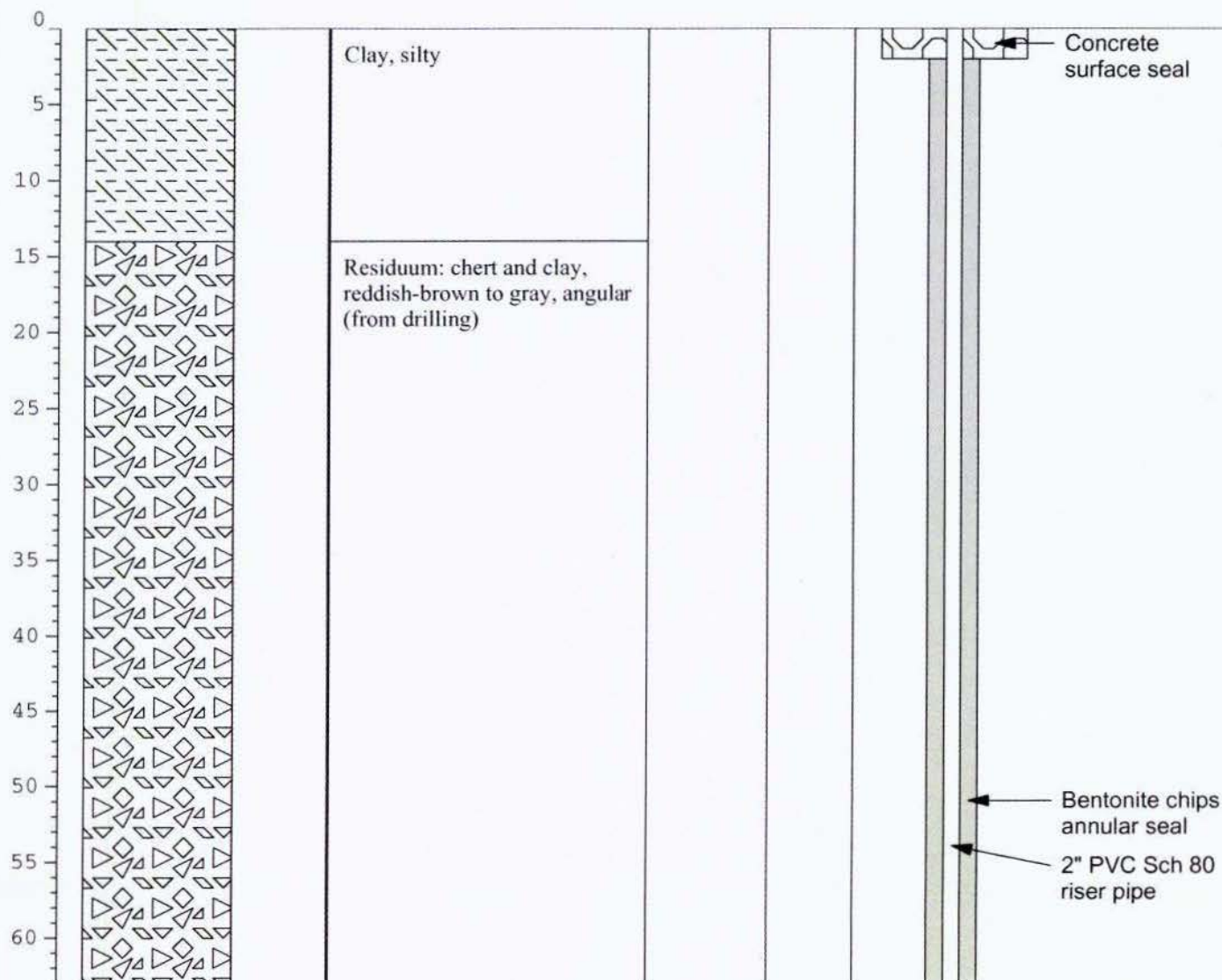
DRILLER: **Dan Nordwald/Glen Young**
RIG TYPE: **Simco 7000**
METHOD OF DRILLING: **6" air hammer**
LATITUDE/LONGITUDE: **N 38 35 50.5 W 90 36 22.4**
SURFACE ELEVATION:
MEASURING PT ELEV: **728.12**

☞ Water level during drilling

☞ Water level in completed well 121.51

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
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NOTES: Above ground completion. Measuring point at top of riser pipe.

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Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: **MW-C02**
TOTAL DEPTH: **168**

PROJECT INFORMATION

PROJECT: **Bliss-Ellisville**
SITE LOCATION: **Callahan Property**
CITY/COUNTY: **St. Louis County**
LOGGED BY: **Glen Young**
PROJECT MANAGER: **Don Van Dyke**
DATES DRILLED: **09-20-2011**

DRILLING INFORMATION

DRILLER: **Dan Nordwald/Glen Young**
RIG TYPE: **Simco 7000**
METHOD OF DRILLING: **6" air hammer**
LATITUDE/LONGITUDE: **N 38 35 50.5 W 90 36 22.4**
SURFACE ELEVATION:
MEASURING PT ELEV: **728.12**

☞ Water level during drilling

☛ Water level in completed well 121.51

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
65			Cherty Limestone: light gray; BURLINGTON-KEOKUK LIMESTONE (minor amount of water in hole at a depth of 70 feet after adding drill rod)				
70							
75							
80							
85							
90							
95							
100			Cherty Limestone: light brown to buff; BURLINGTON-KEOKUK LIMESTONE				
105							
110							
115							
120			Cherty Limestone: gray to bluish-gray; BURLINGTON-KEOKUK LIMESTONE				
125							

← Bentonite chips bentonite seal

NOTES: Above ground completion. Measuring point at top of riser pipe.



MISSOURI

Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: **MW-C02**
TOTAL DEPTH: **168**

PROJECT INFORMATION

PROJECT: **Bliss-Ellisville**
SITE LOCATION: **Callahan Property**
CITY/COUNTY: **St. Louis County**
LOGGED BY: **Glen Young**
PROJECT MANAGER: **Don Van Dyke**
DATES DRILLED: **09-20-2011**

DRILLING INFORMATION

DRILLER: **Dan Nordwald/Glen Young**
RIG TYPE: **Simco 7000**
METHOD OF DRILLING: **6" air hammer**
LATITUDE/LONGITUDE: **N 38 35 50.5 W 90 36 22.4**
SURFACE ELEVATION:
MEASURING PT ELEV: **728.12**

☒ Water level during drilling

☒ Water level in completed well 121.51

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
130							
135							
140							
145							
150							
155							
160							
165							
170							
175							

Diagram of well completion showing:
- Sand pack
- 2" PVC Sch 80 well screen .010 slot
- 2" PVC Sch 80 Bottom cap

NOTES: Above ground completion. Measuring point at top of riser pipe.



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Department of Natural Resources
Division of Geology and Land Survey

Well Construction Log

WELL NO.: **MW-C03**
TOTAL DEPTH: **121**

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	Bliss-Ellisville	DRILLER:	Dan Nordwald/Glen Young
SITE LOCATION:	Callahan Property	RIG TYPE:	Simco 7000
CITY/COUNTY:	St. Louis County	METHOD OF DRILLING:	6" air hammer
LOGGED BY:	Glen Young	LATITUDE/LONGITUDE:	N 38 35 50.3 W 90 36 18.3
PROJECT MANAGER:	Don Van Dyke	SURFACE ELEVATION:	
DATES DRILLED:	09-21-2011	MEASURING PT ELEV:	722.47

☒ Water level during drilling

☒ Water level in completed well

101.16

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
0			Clay, silty				Concrete surface seal
5							
10							
15							
20			Residuum: chert and clay, reddish-brown to gray, angular (from drilling)				
25							
30							
35							
40							
45							
50							
55							
60							
65							

NOTES: Above ground completion. Measuring point at top of riser pipe.

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Well Construction Log

WELL NO.: **MW-C03**
TOTAL DEPTH: **121**

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	Bliss-Ellisville	DRILLER:	Dan Nordwald/Glen Young
SITE LOCATION:	Callahan Property	RIG TYPE:	Simco 7000
CITY/COUNTY:	St. Louis County	METHOD OF DRILLING:	6" air hammer
LOGGED BY:	Glen Young	LATITUDE/LONGITUDE:	N 38 35 50.3 W 90 36 18.3
PROJECT MANAGER:	Don Van Dyke	SURFACE ELEVATION:	
DATES DRILLED:	09-21-2011	MEASURING PT ELEV:	722.47

☞ Water level during drilling

☛ Water level in completed well 101.16

Oct. 6, 2011

DEPTH	LITHOLOGIC SYMBOLS	USCS	LITHOLOGIC DESCRIPTION	SAMPLE	PID ppm	BORING COMPLETION	WELL DESCRIPTION
65			Cherty Limestone: light gray; BURLINGTON-KEOKUK LIMESTONE				
70							
75							
80							
85							
90							
95							
100							
105							
110							
115			Cherty Limestone: light brown to buff; BURLINGTON-KEOKUK LIMESTONE				
120							
125							
			Cherty Limestone: gray to bluish-gray; BURLINGTON-KEOKUK LIMESTONE				

← Bentonite chips
bentonite seal

← Sand pack
← 2" PVC Sch 80
well screen .010
slot

← 2" PVC Sch 80
Bottom cap

NOTES: Above ground completion. Measuring point at top of riser pipe.

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